Lead

Symbol:	**Pb**
Atomic Number: *(protons in nucleus)*	**87**
Atomic Weight:	**207**

What Is It? Lead is an element found naturally in rocks, soil, plants and animals. It typically occurs in combination with other elements as lead salts, some of which are soluble in water. The pure metallic form of lead is bluish-gray, but metallic lead rarely occurs naturally. Lead does not evaporate, but it can be present in air as particles. Because it is an element, lead does not degrade nor can it be destroyed. Several radioactive isotopes are naturally present in the environment, with lead-210 being the isotope of most concern. (Information on radioactive isotopes is presented in the companion fact sheets for radium, thorium, and natural decay series.)

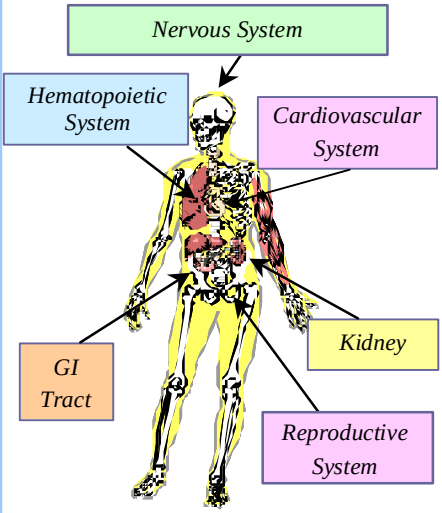
How Is It Used? Lead has been used in a variety of applications for thousands of years. The major use of lead today is in the production of some types of batteries. It is also used in the production of ammunition, metal products (sheet metal, solder, and pipes), medical equipment (radiation shields and surgical equipment), paints, ceramic glazes, caulking, scientific equipment (circuit boards for computers), and high precision glass for lasers and other optical equipment. In recent years, the amount of lead used in products such as paints and ceramics has decreased significantly to help minimize exposure of people and animals to lead. Tetraethyl lead and tetramethyl lead (volatile organic forms of lead) were used for many years in gasoline to increase octane rating. In the United States, this use was phased out during the 1980s, and lead was banned from use in gasoline for transportation in 1996.

What's in the Environment? Lead occurs everywhere in the environment. Concentrations in U.S. soil typically range from less than 10 to 30 milligrams of lead per kilogram of soil (mg/kg). However, amounts in the top layers vary widely and can be much higher due to human activities. For example, concentrations near roadways can be 30 to 2,000 mg/kg higher than natural levels due to past use of leaded gasoline. In air, concentrations range from 0.001 to 0.002 micrograms per cubic meter ($\mu g/m^3$) in remote areas and from 0.2 to 0.4 $\mu g/m^3$ in urban areas. Levels of lead in surface water and groundwater in the United States typically range from 5 to 30 µg/liter. Lead can leach to groundwater over time but is relatively immobile in soil. Concentrations in sandy soil particles are estimated to be 270 times higher than in the water in pore spaces between the soil particles; it binds even more tightly to clay and loam soils, with concentration ratios (above 500 to more than 16,000. Reported concentrations of lead in various foods range from 0.002 to 0.65 mg/kg, with higher levels generally found in vegetables. The typical ratio of the concentration of lead in plants to that in the soil on which they grow is estimated at 0.037 (or 3.7%).

What Happens to It in the Body? Because of its widespread presence in the environment, lead can enter the body by breathing air, drinking water, eating food, and ingesting soil. If air containing lead particles is inhaled, the particles can be deposited in the lungs. Particles deposited in the upper parts of the lung are usually coughed up and swallowed. Particles deposited deep in the lungs dissolve, allowing lead to enter the bloodstream. If lead is swallowed with food, the amount absorbed into the bloodstream is about 6% in a typical adult; however, about 60 to 80% is absorbed in adults who have not eaten for a day. In general, if adults and children ingest the same amount of lead, children will absorb a higher percentage. After lead enters the bloodstream, it travels to all organs and systems. In adults, about 99% of the lead entering the bloodstream leaves the body in the feces or urine. The rest is stored in bones and teeth. In children, about 70% of the lead entering the bloodstream is retained in the body where it is stored mainly in bones and teeth.

What Are the Primary Health Effects? Lead can affect almost every organ and system in the body, including the gastrointestinal tract, the hematopoietic system (blood-forming tissues), cardiovascular system, central and peripheral nervous systems, kidneys, immune system, and reproductive system. Young and unborn children are extremely sensitive to lead. Exposure of pregnant women to high levels of lead can result in premature births and smaller babies, followed by learning difficulties and reduced growth in their children. Similarly, learning difficulties and reduced growth are seen in young children

exposed to lead after birth, as are effects on other organ systems. Although studies indicate that lead acetate and lead phosphate cause cancer in laboratory animals, we do not know if lead can cause cancer in humans ingesting it or breathing it in air. On the basis of the animal studies, the U.S. Environmental Protection Agency (EPA) terms lead a probable human carcinogen.



Organs and systems affected when lead is taken in through food, water, or air.

What Is the Risk? Unlike most other chemicals, the risk posed by inorganic lead is based on predicted or measured levels of lead in blood rather than on toxicity values. The EPA has developed mathematical models for predicting concentrations of lead in the blood of children and adults resulting from exposure to soil, air, drinking water, food, and other sources. The EPA compares the predicted blood-lead concentrations with a concentration of 10 micrograms of lead per deciliter of blood (µg/dL) to decide if lead presents a health risk. The EPA has estimated that the concentration of lead in blood could exceed 10 µg/dL if the concentration of lead in soil at residences exceeds 400 mg of lead per kg of soil. In work areas, the EPA has estimated that the concentration of lead in soil should not exceed 750 to 1,750 mg of lead per kg of soil. Although certain lead compounds have been shown to cause cancer in animals, the risk of cancer is not typically evaluated for lead. This is because people are more sensitive to the non-cancer effects of lead than to the cancer effects. For radioactive isotopes of lead, the cancer risks are included in the risks for radium and thorium (see companion fact sheets for those two radionuclides).

Tetraethyl lead is an organic form of lead that is very toxic. The risk from exposure to this organic compound is evaluated using toxicity values, similar to the approach used for most other chemicals. The toxicity value for estimating potential toxic effects other than cancer is called a reference dose (RfD). The RfD is an estimate of the highest dose that can be taken in every day without causing an adverse non-cancer effect. It was developed by studying test animals given relatively high doses and then adjusting and normalizing those results to a mg/kg-day basis for humans. The RfD used to estimate non-cancer effects from ingesting tetraethyl lead is 0.0000007 mg/kg-day.

What Are Current Limits for Environmental Releases and Human Exposures? To help track facility releases to the environment, the Superfund amendments addressing emergency planning and community right-to-know require that releases of certain chemicals to air, water, or land be reported annually and entered into a nationwide Toxic Release Inventory. Eleven lead compounds are regulated by these amendments. For lead arsenate, a release of over 1 lb (0.454 kg) must be reported immediately, while the quantity for the other lead compounds is 10 lb (4.54 kg). The EPA requires that lead in air not exceed 1.5 µg/m^3 averaged over three months. The drinking water action level for lead is 15 µg/L. The EPA recently announced standards that identified hazardous concentrations of lead as 40 micrograms per square foot (µg/ft^2) in dust on floors and 250 µg/ft^2 for interior windowsills of homes; 400 mg/kg in bare soil in children's play areas; and 1,200 mg/kg in bare soil in other parts of the yard. For workspace air, the Occupational Safety and Health Administration has established a permissible exposure limit (PEL) of 0.1 mg/m^3 for metallic lead and 0.05 mg/m^3 for lead from soluble compounds. If the concentration of lead in the blood of a worker exceeds 50 µg/dL, that worker is not allowed to remain in the work area. Many other regulations and recommendations have been developed for lead to protect public health.

Where Can I Find More Information? More information can be found in the primary information source for this overview: the Toxicological Profile prepared by the Agency for Toxic Substance and Disease Registry (ATSDR), which is available through the Internet at http://www.atsdr.cdc.gov/toxpro2.html. Other Internet sources include ATSDR's ToxFAQS (http://www.atsdr.cdc.gov/toxfaq.html), EPA's Integrated Risk Information System Database (http://www.epa.gov/iris/subst/index.html), and the National Library of Medicine Hazardous Substances Data Bank (http://www.toxnet.nlm.nih.gov/cgi-bin/sis/htmlgen?HSDB).